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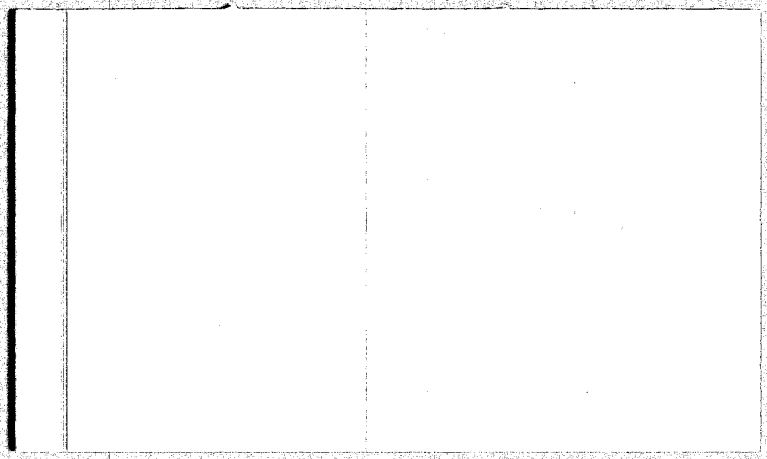

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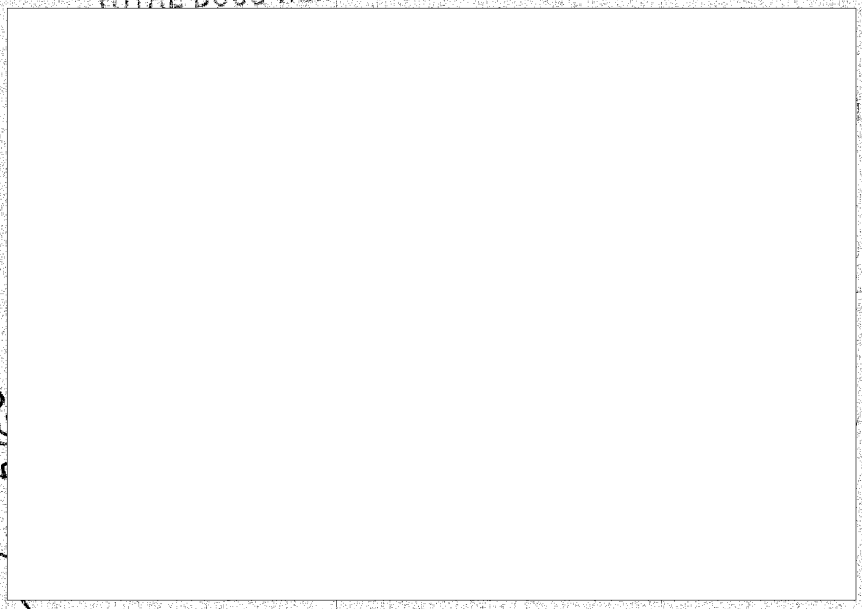

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CONFIDENTIAL

CACHING UNDERWATER 1994
STORAGE CONTAINER

II RESULTS OF INSPECTION OF SEA-WATER-IMMERSED CONTAINERS AND SPECIMENS - CONDUCTED MAY 27-30, 1958

FILE

CONFIDENTIAL

APPENDIX 1

INSPECTION OF ORIGINAL AND MODIFIED ALUMINUM-ALLOY AND STAINLESS STEEL CIRCULAR-CROSS-SECTIONED CONTAINERS

General Fouling Conditions

The fouling noted on the containers inspected was generally moderate to heavy; it was similar to that observed during the previous inspection, conducted on October 27 through November 1, 1957. Details of the fouling condition for each of the containers inspected are presented later under "Detailed Inspection Notes".

Container Performance and General Conclusions

The main performance features observed in this inspection are summarized in Table 1.

The absence of water in Type 1 bare aluminum-alloy Container No. 16 (exposed undisturbed for 30 months) is noteworthy; but, the container cannot be considered satisfactory, because of the difficulty of opening caused by the corrosion-product build-up. The corrosion attack on the container body was relatively shallow - estimated not to exceed 1/32" in depth of pitting. This suggests that the probable service life of the container body might be considerably more than 30 months, perhaps as much as 4 years or more. Although extrapolation on the basis of the evidence from a single container is of doubtful reliability, the condition of the body of another bare aluminum-alloy container [No. 13(M), the body of which has had an interrupted exposure for a total of 25 months] is rather comparable to that of No. 16, and supports a similar conclusion.

TABLE 1. SUMMARY OF PERFORMANCE DATA TAKEN DURING INSPECTION OF MAY 27-30, 1958, ON ALUMINUM-ALLOY AND STAINLESS STEEL CIRCULAR-CROSS-SECTIONED CONTAINERS

Container Number	Description	Duration of Present Exposure	Handles	Retainer-Clip Corrosion	Ease of Opening	Liquid Water Inside	Coating Condition (Where O-Ring Area Coated)	Corrosion in O-Ring Area	Corrosion on Can Body	Disposition
				Original Aluminum-Alloy and Stainless Steel Containers (Types 1 and 2, respectively)						
16	Bare Al; free immersion	30 months	3 seized	Traces of shallow pitting	Lid seized	None	---	Moderate; heavy deposit of corrosion-product present	Scattered pitting, to depth of about 1/32"	Stored at NFRS pending securing new lid
21	Stainless steel; painted with Navy AC/AF system; free immersion	26 months	All free	Moderate at contact points	Easily opened	2 tbsp	---	Shallow, but permitted entry of water	Shallow and scattered, where coating peeled	Stored at NFRS
				Modified Aluminum-Alloy and Stainless Steel Containers (Types 1 and 3, and Type 2, respectively)						
11(M)	Anodized Al; Amercoat AC in O-ring areas; free immersion	21 months	4 seized	None (7-month exposure)	Easily opened	None	Fair; slight blistering and peeling	Slight, where blistered	Scattered pitting, very severe at one lug; body nearly perforated	Replaced on test
13(M)	Bare Al; double O-ring and Amercoat AC in O-ring areas; mudline immersion	13 months	(Nylon) Very slight fraying	1/16"-deep pitting at 2 contact points	Fairly easily opened	None	Ditto	Ditto	Few shallow pits, about 1/32" deep	Ditto
2(M)	Bare Al; neoprene and polyethylene in O-ring areas; free immersion	9 months	(Nylon) Very slight fraying	None observed	Easily opened	None	Very good	None observed	Few shallow pits, about 1/32" deep	"

TABLE 1. (Continued)

Container Number	Description	Duration of Present Exposure	Handles	Retainer-Clip Corrosion	Ease of Opening	Liquid Water Inside	Coating Condition (Where O-Ring Area Coated)	Corrosion in O-Ring Area	Corrosion on Can Body	Disposition
18(M)	Chromate-treated Al; epoxy resin in O-ring areas, plus rubber cap; free immersion	13 months	(Nylon) Very slight fraying	Traces of white corrosion product; no pitting	Easily opened	None	Fair to poor; blistering and peeling	Slight where coating peeled	Possible traces of very shallow pinpoint pitting; shallow pitting where fouling rubbed off by line	Replaced on test
22(M)	Stainless steel; Amercoat AC in O-ring areas; free immersion	13 months	All free	Not recorded	Easily opened	10 qt	Very poor; essentially failed by blistering and peeling	Deep on edge of can lid and head	Pinpoint perforation in heat-affected zone of weld at lug; shallow elsewhere	Stored at NFRS

Note: NFRS = North Florida Research Station, Daytona Beach, Florida.

Type 2 painted stainless steel Container No. 21 (exposed for 26 months undisturbed) cannot be considered satisfactory, because of leakage, presumably due to corrosion at the O-ring-seal areas. The amount of water in the container, however, was small (2 tablespoonsful). The value of the Navy AC/AF system in protecting and reinforcing the closure, when the system was applied after closing, is again confirmed. The depth of corrosion at the O-ring contact line was appreciably less in this container than that recorded for bare stainless steel Containers Nos. 22 and 24 when inspected December 3-5, 1956, after only 8 months of exposure. On the can body, the Navy AC/AF system gave good protection against both corrosion and fouling where the coating remained intact; but, the rather poor adhesion of this system to stainless steel was again confirmed, both by the presence of large peeled areas and by the ease with which the remaining intact coating could be stripped off.

Type 1 aluminum-alloy Container No. 11(M), modified by using the Amercoat AC system in the lid and head O-ring areas, was still in satisfactory condition, after an exposure of 21 months following modification. Container No. 11(M) had been opened and reclosed three times prior to the present inspection. The Amercoat AC was still preventing corrosion at the O-ring seal, but was continuing to fail slowly by blistering and peeling, apparently hastened somewhat by undercutting from the edge of the painted area. The Amercoat AC performance might have been improved by painting a larger area, thereby displacing the edge of the coating to a position more remote from the critical O-ring-seal areas. The body of No. 11(M) has had a total exposure of 27 months (out of the sea water for 3 months for

modification). The deep pitting at the lug noted in this inspection suggests that the further service life of this container will probably be short. This emphasizes the importance of extending the weld metal completely around the lug, to eliminate the crevice where this corrosion was occurring. A comparison of the body of No. 11(M), which was anodized, with that of No. 16, which was bare, suggested that the anodized body suffered more corrosion attack than did the bare body.

Modified Type 1 aluminum-alloy Containers No. 13(M) (double O-ring and Amercoat AC in the O-ring areas) and No. 2(M) (polyethylene on the can head and neoprene on the lid, in the O-ring areas) have been exposed 13 and 9 months, respectively, since modification. The Amercoat AC on No. 13(M) is still generally intact, but shows signs of incipient failure by blistering and peeling. The coatings on No. 2(M) are in excellent condition, definitely better than was the Amercoat AC after 7 months of exposure*. The neoprene coating appears to be especially promising with respect to corrosion protection and adhesion. The body of No. 13(M) has had a total exposure of 25 months (5-month interruption for modification) and showed relatively little corrosion attack; this again suggests superior corrosion resistance for the bare as compared to the anodized aluminum alloy under these exposure conditions.

Modified Type 3 aluminum-alloy Container No. 18(M) (epoxy coating in the O-ring areas plus a neoprene cap) was in good condition after 13 months of exposure. But, the epoxy coating continued to show signs of incipient failure by blistering and peeling. The rubber cap was very

*See letter report dated May 27, 1957.

useful in preventing fouling of the closure and thus facilitated opening the container, even though the cap leaked. Corrosion of the bare aluminum-alloy retainer clip did not appear to be accelerated by the presence of the cap or the resulting accumulation of sea water.

Modified Type 2 stainless steel Container No. 22(M) (Amercoat AC in the O-ring areas) was unsatisfactory; it had failed by perforation in the heat-affected zone around one of the lugs after 21 months of total exposure at the time of this inspection (with a 5-month interruption for modification). However, the Amercoat AC had also essentially failed, except on the O-ring contact line, by blistering and loss of adhesion, though not enough to permit leakage.

The fouling accumulation on the head and lid significantly lengthened the time involved in lid removal on Containers Nos. 2(M), 16, and 21. Since modified aluminum-alloy Container No. 2(M) had been exposed only 9 months, it is evident that for any prolonged exposure in tropical or sub-tropical waters, some antifouling protection of the closure is highly desirable. Because of the difficulty of maintaining an antifouling paint over the surfaces of the closure, the rubber cap as used on No. 18(M) appears to provide a good solution to this problem.

The nylon rope handles on Containers Nos. 2(M), 13(M), and 18(M) were still in good condition. They showed only slight surface fraying after a maximum exposure of 13 months.

Detailed Inspection Notes

Bare Aluminum-Alloy Container - Free Immersion (No. 16)

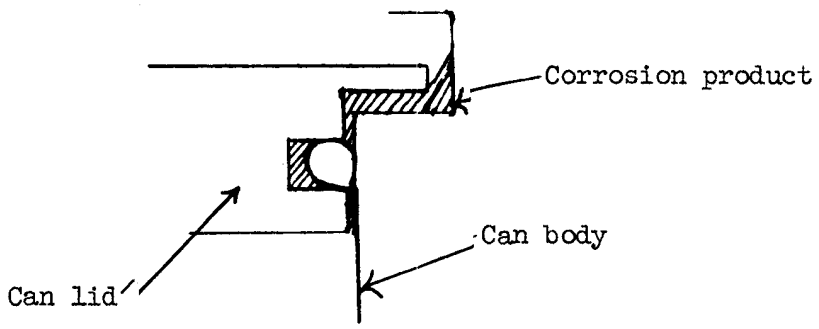
(Exposed for 30 months, starting December 1, 1955.)

Fouling very heavy over entire can body, head, lid, and retainer clip. Mainly barnacles up to 1" in diameter (mostly 3/4"), so thickly set that almost entire can surface covered. Also a few encrusting bryozoa and oysters, up to 1-1/2" in diameter.

Three handles seized by corrosion. The one free handle is one of two to which bridle lines were attached. Retainer clip removed by hand with some difficulty, because of heavy fouling on surface of can lid and head. Difficulty also encountered in removing hard fouling from groove in can head. Traces of shallow pitting on retainer clip, primarily at points of contact with can lugs and head; elsewhere, retainer clip appeared to be in good condition. Attempts to open lid by using new retainer clip and prying on lugs failed. Nail bar used in attempt to remove lid; all three lugs broken off. Lid finally removed by bumping with ballast; as a result, 2"-long crack occurred in lid.

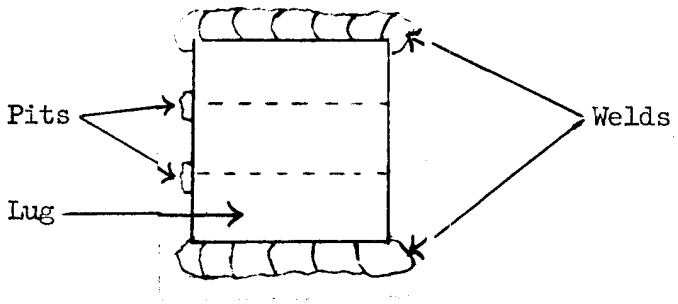
No moisture or water inside can. Space between O-ring and O-ring groove in can lid filled with dry, hard, gray corrosion product which had smooth, glassy surface where in contact with O-ring. Similar product occupied space between lid and can head exterior to O-ring, and extended beneath O-ring to interior of can head. This corrosion product made removal of lid difficult. Through build-up of corrosion product in O-ring

groove, O-ring deformed in cross section, being ovate with lip projecting toward interior, thus:



Interior of can head showed shallow etching mainly along original line of contact with O-ring, and extending toward interior.

Approximately 1/4 of can body, including two handles, was cleaned and examined for corrosion attack. Two small pits, 1/16 to 1/8" in diameter, estimated to be 1/64 to 1/32" deep, found. Shallow etching and pitting also found associated with handle lugs, thus:



This attack much less severe than that noted on Container No. 11(M).

Container stored at the NFRS, pending receipt of a new lid. If a lid can be secured, the specimen will be replaced on exposure.

Painted* Stainless Steel Container -
Free Immersion (No. 21)

(Exposed for 26 months, starting March 29, 1956.)

Heavy fouling, consisting of annelids, barnacles, and oysters in patches up to 1 ft in diameter, covering about 2/5 of can surface. Coating intact and appeared to be in good condition except for a few 1 to 1-1/2"-diameter patches, where coating peeled to metal as a result of detachment by fouling. Probing with knife indicated that adhesion of coating poor to fair. In vicinity of patches of fouling, coating could be peeled to metal with little difficulty. Fouling heavy on can lid and head, and at joint between lid and can.

All four handles free and easily worked by hand. Retainer clip removed by hand with difficulty, due to fouling on lid and adjacent can head. Interior of groove on container head filled with dense, hard fouling, which was removed by using tip of retainer clip. Cleaning groove in this manner was very difficult because of tight adhesion of fouling and inadequacy of tool. On removal of fouling from groove, lid popped out of can as a result of internal air pressure built up by exposure of can to ambient temperature.

Retainer clip, which had also been painted, was corroded in three areas where in contact with head and lugs. This is generalized type of corrosion extending approximately 1" to either side of point of contact of clip and lug. Reduction in diameter of clip at points of deepest corrosion probably not more than 1/32 to 1/16".

*With complete Navy vinyl AC/AF system.

Can contained about 2 tablespoonsful of rusty water; lower side of ballast showed light corrosion. Shallow corrosion groove around about 1/3 of circumference of container head, on line of contact of O-ring with head. Around rest of circumference, interior of can head bright and in original condition. Corrosion groove generally about 1/8" wide, but in some places spread to wider etched area, on both sides of contact line, indicating penetration of water beneath O-ring.

Lid showed very shallow corrosion in O-ring groove, along line of contact of O-ring, around about 3/5 of circumference of O-ring groove. This corrosion area, in most instances, was about 1/8" wide, although wider toward the exterior of the groove at some points. It was rather shallow, probably not over 1/64" deep.

Coating on exterior of can head and lid intact over most of surface, except at extreme edges where it peeled, allowing corrosion attack along edge and at two lugs. One lug lost entirely by corrosion and large part of associated weld metal also corroded away. Second lug lost outer 1/3, which forms hook, by corrosion; deep pitting attack around base, where attached to lid. Third lug intact, but showed shallow corrosion at base.

Upon removal of patches of fouling from can body, it was found that most of fouling was directly on metal, indicating that coating had peeled to metal before fouling occurred. In few small areas, fouling was directly on coating, possibly indicating abrasion of antifouling coat. Examination of metal beneath fouled areas showed number of points of shallow corrosion attack mainly beneath barnacle bases, in areas approximately 1/4

to 1/2" in diameter. In no case was attack very deep - estimated to be not more than 1/64" deep. This suggested that peeling of anticorrosive coat to metal had occurred rather recently; from size of barnacles, it might be judged to have occurred within the past year.

Container removed from test and stored at the NFRS.

Modified Anodized Aluminum-Alloy Container - Free Immersion [No. 11(M)]

(Exposed for 6 months - December 1, 1955 - June 5, 1956; modified by coating O-ring areas on lid and can head with Amercoat AC system; returned to free-immersion exposure August 29, 1956; opened and inspected December 3, 1956, March 29, 1957, and November 1, 1957; total immersion time of modified container before current inspection - 21 months.)

Fouling moderate over can body, head, and lid. Mainly oysters, up to 1" in diameter, and barnacles, up to 3/4" in diameter.

All four handles seized by corrosion. Retainer clip removed by hand with no difficulty. Lid removed by prying with clip against lugs, with very little difficulty.

Interior of can entirely dry. Several blisters, one 2" long, on can lid, mostly exterior to O-ring groove; one blister extended to outer edge of groove. Coating peeled to primer in one small area on lid shoulder at outer edge of groove. Clots of white, gelatinous corrosion product outside of O-ring, probably originating from blisters mentioned before. Coating on lid, to interior of O-ring groove, in perfect condition and showed no evidence of blistering or peeling. Traces of peeling to primer on outer lip of lid in small patches. O-ring in perfect condition and showed

no evidence of deformation. Coating on interior of can head in nearly perfect condition, in and around O-ring contact line, except for slight pressure grooving along line of O-ring contact. Coating on interior of can flaked to metal in 1/4"-diameter area, exterior to O-ring contact line. This was apparently site of a blister which had formed on shoulder of can head and had been broken on opening of can. This peeled area identified for future reference by means of a blue crayoned arrow on interior of can.

Retainer clip showed no evidence of corrosion. However, this clip was installed after previous inspection (November 1, 1957), and has been in service for only 7 months.

Fouling removed from portion of can body, including two handles, for corrosion inspection. General surface condition about as described at last inspection, i.e., sites of old fouling bases unaffected, with some general corrosion occurring in areas where bases not present. In addition, scattered small points of rather deep corrosion (pitting) over can body, randomly distributed, penetrating about halfway through body metal. Most serious attack is at handle lugs, e.g., at lower handle lug stamped with can number. At this lug, deep pit 3/8" in diameter, penetrating under lug, thus:

This pitting occurred at a weak point in the design. The situation has already been remedied by extending weld metal completely around lug base.

Container reclosed and replaced on exposure.

Modified Bare Aluminum-Alloy Container - Mudline Immersion [No. 13(M)]

(Exposed for 12 months - December 1, 1955 - December 3, 1956; modified with double O-ring and Amercoat AC system in O-ring areas; replaced on mudline exposure April 23, 1957; opened and inspected November 1, 1957; total immersion time of modified container before current inspection - 13 months.)

Fouling very light on portion of can above mudline. Scattered barnacles up to 3/8" in diameter; few encrusting and filamentous bryozoa, annelids, and mollusks. Encrusting bryozoa and annelids covered rubber tire and periphery of can head and lid.

All four rope handles apparently in good condition, with trace of fraying of fibers at surface. Retainer clip removed with only slight difficulty from fouling. Can lid removed with slight difficulty by prying with retainer clip.

Interior of can completely dry. Coating in inner O-ring groove in perfect condition. In outer O-ring groove, trace of blistering on exterior side of groove, but not extending beyond O-ring contact line. Several blisters, 1/4 to 1" long, on shoulder of can lid just exterior to outer O-ring groove; two of these broken and filled with white corrosion product. Coating peeled to primer or metal in several 1/4 to 1/2"-diameter patches on overhanging lip of lid, and at points of contact with retainer clip.

Coating on interior of can head in good condition, except for three 1/4"-diameter blisters, two of which are just exterior to line of contact of outer O-ring and one just interior to contact line. Exterior blisters broken on lid removal. Coating had shallow pressure groove at contact line of each O-ring, approximately 1/64" deep, with narrow ridge of coating at interior side of each groove. Coating peeling to primer or metal, apparently where blistered, in several spots on interior of retainer-clip groove. Several large areas of white corrosion product on retainer clip at points of contact with can or lid. Deep corrosion attack or pitting at two of these contact points, with penetration up to about 1/16".

Portion of can body cleaned for inspection. One shallow pit found on can body just above mudline, about 1/32" deep. Elsewhere on above-mudline portion, only possible traces of pinpoint pitting under barnacle bases. One shallow pit about 1/32" deep on below-mudline portion. No corrosion on can body at point of attachment of handle lugs, but one deep pit in weld metal at one lug.

Container reclosed and replaced on exposure.

Modified Bare Aluminum-Alloy Container - Free Immersion [No. 2(M)]

(Exposed for 12 months - December 1, 1955 - December 3, 1956; modified with a flame-sprayed polyethylene coating in the O-ring area of the container head* and a neoprene coating in the O-ring area of the lid; exposed on free immersion August 28, 1957; total immersion time of modified container before current inspection - 9 months.)

*The three other containers in this modification group [Nos. 1(M), 12(M), and 14(M)] have neoprene coatings on the O-ring areas of the heads and the lids.

Entire container body and lid heavily fouled, mainly by barnacles up to 3/4" in diameter, and few encrusting bryozoa and annelids. Barnacles so thickly set that they cover practically all of can surface. Joint between can head and lid almost entirely covered with heavy fouling, mainly oysters, and a few barnacles.

Two rope handles in good condition except for trace of fraying. (No handles on opposite side; bridle lines attached directly to lugs.) Retainer clip removed with considerable difficulty because of very heavy fouling on can lid and head. Lid removed easily by prying with retainer clip.

Interior of can completely dry. Polyethylene coating on interior surface of can head appeared to be in perfect condition, and showed no pressure grooving on O-ring contact line. Neoprene coating on can lid also appeared to be in good condition; pressure groove, estimated 1/32" deep, at O-ring contact line. Coating on interior of groove perfect, and on exterior of lid seemed to be in good condition, as far as fouling would permit inspection.

Retainer clip in good condition, but was twisted out of shape on removal, due to interference by fouling. No evidence of corrosion at points of contact with lid and head.

Portion of can body cleaned and inspected for corrosion. Few shallow pits, 1/32 to 1/16" in diameter, and estimated to be less than 1/32" deep. No corrosion associated with two handle lugs examined.

Container reclosed and replaced on exposure.

Modified Aluminum-Alloy Container* -
Free Immersion [No. 18(M)]

(Exposed for 12 months - December 1, 1955 - December 3, 1956; modified with epoxy resin in O-ring areas on can head and lid, plus neoprene-rubber "bathing" cap over head and lid; replaced on free-immersion exposure April 23, 1957; opened and inspected November 1, 1957 - new O-ring installed and can re-immersed; total immersion time of modified container prior to current inspection - 13 months.)

Rubber cap held about 1 to 1-1/2 qt of water; this had apparently entered through small leak at periphery, since leakage of contained water occurred at this point after removal of can from water.

Fouling moderate to heavy over entire can body. Oysters up to 1-1/2" in diameter; barnacles up to 3/4" in diameter.

All four rope handles in good condition, except for trace of fraying on one, caused by plastic-covered tag wire, and on two handles to which bridle lines attached. Rubber tire easily removed by hand. Retainer clip easily removed; traces of white corrosion product on clip, but no evidence of pitting. Lid removed easily using clip.

Interior of can completely dry. Many blisters, mostly 1/8" in diameter, up to 1" long, in retainer-clip groove. Coating in perfect condition in O-ring groove and on interior of lid past groove. Coating on interior of can head in good condition, but deeply pressure grooved on line of O-ring contact, to depth of about 1/64+". On can head, few small 1/8"-diameter blisters on outer lip just outside of groove. Coating on outer

*Originally, this container had been chromate treated and then painted with the Navy AC/AF system. Prior to modification, all of the paint had been removed.

surface of lid flange, where contacted by retainer clip, blistered over 75+% of surface, and peeling in several spots.

No corrosion on portion of can body cleaned and examined, except possibly very minute pinpoint pits. However, in one area where line had rubbed across surface keeping 3/4 x 2" area clean, numerous shallow pits more than 1/64" deep. One deep pit, 1/32" in diameter, in weld metal at lug, but no attack on body metal at lug.

Container reclosed, rubber cap replaced, and container reinstalled on exposure.

Modified Bare Stainless Steel Container - Free Immersion [No. 22(M)]

(Exposed for 8 months - March 29, 1956 - December 3, 1956; modified with Amercoat AC system in O-ring areas of can head and lid; returned to free-immersion exposure April 23, 1957; total immersion time of modified container before current inspection - 13 months.)

Container not buoyant when detached from anchor - obviously partly filled with water. Fouling moderate over entire can body and lid. Portion of can head (1/2 of circumference) free of fouling, apparently from working of line across metal. Fouling mainly barnacles up to 3/4" in diameter, and a few oysters, and encrusting and filamentous bryozoa.

All four metal handles free and easily worked by hand. Retainer clip removed readily by hand. Lid removed with very little difficulty by prying with retainer clip.

Can contained about 10 qt of water; ballast steel showed considerable corrosion. Examination of lid and can head failed to show how water

entered. Paint covering was in poor condition, being severely blistered both inside and outside of line of contact of O-ring and can head, and in O-ring groove of lid. However, line of contact between O-ring and can head appeared to be in good condition and O-ring itself showed no defects. Deep corrosion of can head primarily on edge of flange which forms groove for retainer clip - penetrating to depth of about 1/8".

After can body cleaned of fouling, a number of deep pits found in heat-affected zone surrounding handle lugs, and in weld joint between can bottom and body. When can was intentionally filled with water, leakage was noted through pinpoint hole in one of pits associated with handle lug. Elsewhere on can body, a few circular areas of deep etching, 1/2 to 3/4" in diameter, associated with barnacle bases.

AC coating showed many blisters, 1/8 to 3/4" in diameter, on interior of can head on both sides of O-ring contact line, but not on contact line; paint peeling to metal in number of places. Coating adhesion lost throughout retainer-clip groove, and coating peeling. Severe blistering of coating on can lid on both sides of and in O-ring groove. Several blisters, 2 to 3" long, parallel to groove, extended under O-ring, but were flattened at contact line. Coating largely peeled away on outer lip of lid. In spite of paint failure on lid and head, it was concluded that lid seal not responsible for leakage, and that the water within the can had penetrated through perforation noted above.

Container removed from test and stored at the NFRS.

APPENDIX 2

INSPECTION OF SPONSOR'S VARIOUS RECTANGULAR-CROSS-SECTIONED STAINLESS STEEL CONTAINERS

7" x 9" x 16" Stainless Steel Containers Coated With Olive-Drab Paint

The remaining two containers of this type had been exposed to sea water for 30 months, starting December 1, 1955. They had been attached to the floating dock, and thus had been subjected to continuous immersion at a depth of approximately 18".

Inspection on May 28, 1958, showed that both containers were covered with heavy fouling, up to about 1" in thickness. Mostly barnacles, and a few oysters, were observed.

Container No. 1 (identified arbitrarily) contained water to a depth of 1". The lid was perforated from the interior out (in the crevice between the lid and the flat gasket) at 8 points. Deep-etching attack was evident under the gasket around the entire periphery of the lid, and this extended toward the interior edge of the gasket around most of the periphery. Evidently the water gained entrance through these etched areas. Numerous areas of shallow etching, 3/8 to 1" in diameter, were noted on the can body where the coating had peeled.

There were about 3 tablespoonsful of water in Container No. 2 (arbitrarily identified). The lid was perforated from the interior out (in the crevice between the lid and the flat gasket) in an area approximately 1" in diameter. Shallow to deep etching was observed under the gasket around about 2/3 of the periphery; this type of corrosion attack extended toward the interior edge of the gasket in several areas. It was deduced that the

water entered through these areas. Numerous areas of shallow etching, 3/8 to 1" in diameter, were observed on the can body after the fouling had been removed.

In view of the results obtained, this type of container (reportedly designed for underground-burial service) is considered unsatisfactory for prolonged service under sea-water-immersion conditions, because of susceptibility to crevice corrosion between the flat gasket and the lid. Containers Nos. 1 and 2 were stored at the NFRS.

Painted 7" x 9" x 8" Stainless Steel Containers

Four containers, furnished by the Sponsor, had been coated in Columbus with the Amercoat AC system on the entire exterior, on the interior surfaces of the lid, and on the upper 1 to 2"-deep areas of the body interior. The units had then been attached to the floating dock on April 17, 1957, and continuously immersed at a depth of 18".

Inspection of all four of these containers after 13 months of immersion revealed heavy fouling. Primarily barnacles, up to 3/4" in diameter, and oysters, up to 2" in diameter, were observed on all of the cans.

A superficial check was made for the presence of water in all of these cans by shaking them manually and listening for the sound of sloshing. It appeared that none of them contained water.

In a cursory examination of the exteriors of Containers Nos. 21, 22, and 24 made without disturbing the fouling, these cans appeared to have lost the top (AC) coating down to the primer over 25 to 50% of the surface area. Also, in a few areas, 1/2 to 1" in diameter, the coating was peeled to the metal.

Container No. 23 was opened and found to be completely dry. The coating was peeling to the metal or to the primer in many areas, 3/8 to 1" in diameter, on the body and lid, apparently as a result of the action of the fouling on blisters. On the front left corner about 1/2" below the top of the can, the coating was peeling to the metal in a 1/4"-diameter area; the location of this area was correspondingly marked on the can interior with colored wax pencil. The rubber gasket apparently had been installed in an upside-down position; after the inspection, it was re-inserted in the same (wrong) position. Some of the fouling was removed from the body, lid, and latch area to facilitate the inspection; traces of corrosion were noted along the hinge and corners of the lid where the AC coating was imperfect, as evidenced by red rust stains.

All four of these containers appeared to be in satisfactory condition. They were replaced on exposure.

APPENDIX 3

INSPECTION OF SAMPLES OF MISCELLANEOUS NONMETALLIC MATERIALS

On July 12, 1957, neoprene-rubber, silicone-rubber, polyethylene, Teflon, Tygon, and impregnated-Fiberglas panels, and Dacron and polyethylene ropes, had been attached to the dock and immersed in sea water. The results of the 10-month inspection are presented below. After the inspection, all of these specimens were replaced on exposure.

In summary, five of the six rubber and plastic materials exposed as panels were in good condition. The exception was Tygon, which was perforated extensively by pholad borers and scored on the surface by barnacles. This material appeared to be unsuitable for sea-water service. Interestingly, the silicone-rubber panel was found to have collected much less fouling than did the other panel materials; this observation suggests that silicone rubber may be an even better material than neoprene for the "bathing" cap used on the Type 3 containers. The Dacron and polyethylene ropes were in good condition.

Neoprene-Rubber Panels

The present color was black. The fouling was moderate to heavy and consisted of barnacles, up to 3/4" in diameter; oysters, up to 1-1/2" in diameter; and a few annelids and bryozoa. The panel showed some sagging and warping, apparently due to the presence of the fouling. However, there was no evidence of deterioration of the neoprene; the rubber was still quite elastic.

Silicone-Rubber Panels

This material was gray in color. The fouling was very light and consisted of loose and tight barnacles, from seed size up to 1/4" in diameter, a few colonies of orange sponge, algae, and scum. In general, the amount of fouling was much less than that noted on the neoprene panel. The panel was in good condition; no wrinkling or other signs of deterioration of the material were observed.

Polyethylene Panels

This material was white in color, and was translucent to opaque. The fouling was very heavy and consisted primarily of barnacles, up to 1" in diameter (mosly 3/4" in diameter). The condition of the polyethylene was good. Slight warping of the panel was evident, but no cracks or other signs of deterioration of the material were noted. The polyethylene was still flexible.

Teflon Panels

This material was white and opaque. It had accumulated heavy fouling, which was comprised primarily of barnacles, with some annelids and sponge. The surfaces were almost completely covered with barnacles, 3/16 to 3/8" in diameter, with a few as large as 3/4" in diameter; the barnacles were generally smaller than those noted on the polyethylene. The Teflon appeared to be in good condition, and did not evidence cracking or other signs of deterioration; it was still somewhat flexible.

Tygon Panels

This material was heavily fouled, primarily by barnacles, up to 1" in diameter, and also by a few oysters and encrusting bryozoa. The panels were severely warped, but the material was still flexible. The surfaces were lightly scored by barnacle bases, and penetrated or perforated by borers (pholads); about 1/3 of the area of one panel showed 7 pits or perforations, 1/8+" in diameter.

Impregnated-Fiberglas Panels

This material was darkish blue in color, and was heavily fouled; barnacles up to 3/4" in diameter (mostly 5/8" in diameter) were so thickly set that the entire panel surfaces were covered. The fouling was quite adherent and could be removed only with difficulty. No warping or evidence of material deterioration was observed; however, in selected, irregular areas, the blue color was being lost.

Dacron and Polyethylene Ropes

Both types of rope showed slight surface fraying; "fuzzing" of the surface fibers was visible. It might be worth while to perform breaking tests on these ropes.